

Detail Design and Manufacturing Result of the HANARO Cold Neutron Source Moderator Cell

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1. Introduction

Moderator cell which is on the process of developing is the core of the Cold Neutron Source(CNS) and operates at cryogenic of 20K and made of aluminum. When infer from experience in all nuclear reactors that use moderator cell, Aluminum has a proper nature to use at cryogenic that use hydrogen. And a lot of data was already published for the Aluminum characters which are in the investigative state[1]. Because performance of moderator cell is getting better when thickness is thinner, moderator was designed to double cylinder type of thin plate style. Aluminum is excellent both manufacturing and welding. If the plate is less than 3.0mm, manufacturing and welding are difficult. Because of this, after making a moderator cell, manufacture and integrity are evaluated. In this paper, detailed design of moderator cell and manufacturing result are described.

2. Detailed design of moderator cell

For the manufacturing, structure integrity, fluidity of hydrogen, thickness, radius curvature, welding form, and welding region of nucleonic moderator cell was designed in detail.

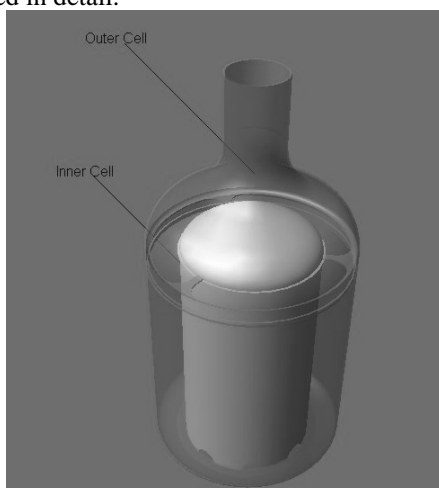


Figure 1. Three dimension(3D) modeling of moderator cell

2.1 Thickness of moderator cell

Outside of moderator cell was designed to circle cylinder type to produce maximum beam-tube cold

neutron from the cold neutron source of Cold Neutron(CN) hole in HANARO. According to nucleonic result, when the thickness of moderator cell is 2.5cm, confirmed to get most suitable cold neutron flux[3]. As the first step, designed 1.2mm(t) moderator cell and then decided to examine the possibility of manufacturing. Based on the manufacturing result, decided to make a final decision of thickness.

2.2 Radius curvature of moderator cell

According to the nucleonic result, when upper and lower part of circle cylinder cell-like moderator cell-is orthogonal, obtained conclusion that cold neutron source flux is good. If upper and lower part are orthogonal, both structural and hydrogen liquidity aspect are disadvantageous. Therefore, must make curvature, even though 1~2% of reduction of cold neutron is generated[3]. For the method of curvature, considered liquidity by making curvature at upper part of corner part and moderator cell and linked liquid hydrogen transfer piping. Elliptical is defined as width and length and width is decided by width of cell and length is designed 17mm height according to the result that 10~25mm is suitable by nucleonic calculation result.

2.3 Welding form and welding region of moderator cell

The form of moderator cell is divided into several products and designed a cell that has body and upper part with minimized shut. Welding method was selected for the link of body and upper part because of gas tight of cell and mass reduction. when weld, depth of penetration is thin, and energy density is high, and decided by electron beam welding that when weld, danger of oxidation is less[4]. Shut designed upper course in addition as thickness of cell in inside diameter of body on upper part and hitch upside of body and this designed to improve stiffness and stiffness of deeply welded welding of shut when weld.

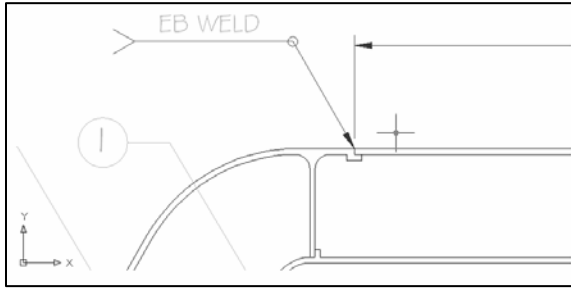


Figure 2. Welding region shape of moderator cell

3. Manufacture result of moderator cell

Manufacture of moderator cell was propelled by strategy that secure last 2set after preparing 5set minute's material taking into account trial and error and produced via HANARO quality T class[2].

3.1 Manufacture process of moderator cell

When consider the characteristic of moderator cell, the number of welding times is very important. Generally, to make pressure cell, it is necessary to weld at least 2 or 3 parts of pressure cell. Moderator cell was designed to have one part of welding, and cutting method was selected, instead of bending and pressing one. Produce inner and outer space of moderator cell except for the thickness of cell, moreover there are a lot of difficulties to produce. When processing method strengthens simplicity dental plaques that touch in inside diameter after processes first inside diameter accurately and processes reverence, seismic center and cylindricality of cell did not scatter and process surface at high speed to improve degree and improved quality of cell.

3.2 Welding process of moderator cell

For the welding of moderator cell, make a welding condition through 2 times experiment. See important condition of them.

Table 1. Main welding condition

Chamber Vacuum	2×10^{-4} torr
Penetration	1.5mm
Accelerating voltage	60kV
Beam current	25mA
Focal distance	210mm
Welding speed	600mm/min
Welding time	40sec

3.3 Dimension test of moderator cell

Tested measurement of After parts welding and before welding assembly and confirmed the result that the measurement was belonged to design common difference by report and examination. Examination confirmed seismic center, assembly common difference of geometric tolerance measurement and importance

assembly region about cylindricality, welding region common difference, length common difference etc.



Figure 3. Shape of manufactured moderator cell

4. Conclusion

1.2mm thick moderator cell was successfully manufactured by 6061 T6 alloy. The product passed the visual and dimension inspection including welding part. Following this result, 1mm thick cavity type moderator cell is to be manufactured according to same fabrication procedure and the design for new 1mm thick product was completed. For cell assembly, NDT(Non Destructive Test), leak test, tensile tests of welding part at room temperature and cryogenic temperature and microstructural examination of welding part will be performed.

Acknowledgements

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